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PAMI *Research Update*

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746

Converting a Field Cultivator for Row Crop Use

Find an old field cultivator and convert it for your new row crops!

Are you looking for ways to diversify your farm production?

Many producers in Saskatchewan are looking to row crops, and particularly herbs and spices as alternatives, but need cultivation equipment suited to growing row crops. But you may not need to buy new equipment—you may be able to modify an inexpensive older machine yourself.

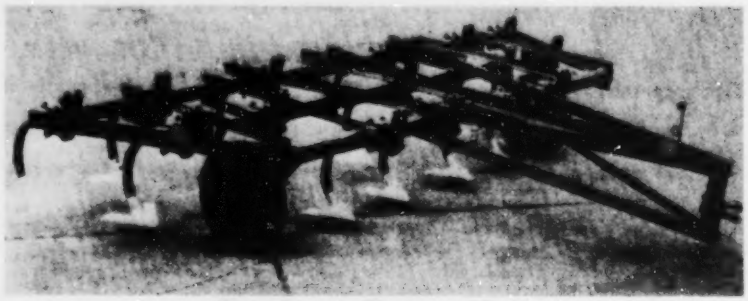

Photo Source: Province of Saskatchewan Agricultural Machinery Administration

Some degree of tillage is required for herb and spice production, either due to organic requirements or due to a lack of registered herbicides. Some producers prefer the small single row tillers or three-point hitch equipment more commonly found in market gardens, while others would rather use a larger cultivator. In either case, older hitch-drawn cultivators are plentiful on the Prairies, and serve as excellent candidates for conversion to row-crop use.

To find out more, PAMI contacted herb growers to gather information on their use of tillage equipment and to find older cultivators that had already been converted into row crop machines.

At a Glance

Most older field cultivators are suitable for modification for row cropping. Your specific needs will be determined by the crops you grow and the tractor power available.

Factors you'll want to consider include row spacing and row spacing flexibility, whether you need a towed or tractor mounted unit, frame size and layout, ease of levelling, ease of moving, removing, and replacing shanks, overall machine condition, and the robustness of the shanks.

You may also want to add some type of guidance system to keep the machine on track, and prevent shovels from wandering into crop rows.

Choosing a Cultivator

No one make of machine is necessarily better suited to conversion then another. Growers must assess their own situation regarding crops, conditions, tractor to be used, availability of a second operator, etc. and then evaluate the available cultivators to determine how well suited they are for conversion.

Cultivator Mounting Position

Cultivators can be either drawn, front mounted or three-point hitch mounted. What follows are some pros and cons of each type.

Drawn Cultivators: Hitch movement and the length of the drawbar can cause side to side movement of the cultivator. This can be to the operator's advantage if guide wheels are used, allowing slight lateral shifts of the machine to line up with the rows. Drawn cultivators typically don't need any hitch modifications.

However, a drawn cultivator is positioned far behind the tractor operator's position, making it hard to see crop damage or make minor steering changes to prevent crop damage. A cultivator steering mechanism may be needed with either a second operator riding on the cultivator or an automatic guidance system to make tracking adjustments as the cultivator travels down the rows.

Three-point Hitch Mounts: Farmers with three-point hitch equipped tractors will appreciate having the tillage tool closer to the operator's position, improving visibility and allowing more positive tracking control. However, tractor steering corrections amplify movement of rear mounted cultivators in the opposite direction, threatening crop rows. Shorter cultivators work better with these systems and depending on row space, a single or double rank machine may be the best.

Front Mounted (Push Style): Mounting the cultivator in front of the tractor and pushing it provides the operator with good visibility and manoeuvrability while cultivating (Figure 1), eliminating additional guidance systems or a second operator. Although not a traditional position for a pulled machine, the concept appears to have merit, especially for the smaller size of older cultivators.

Two concept drawings (Figure 1 and 2) have been included to show some possibilities. Either a push pole or a three-point lift device on the front of the tractor could be used to control the cultivator. The largest effective cultivator width will be a function of tractor weight, as heavy forces from stones applied to the outer ends of the cultivator may push the tractor around.

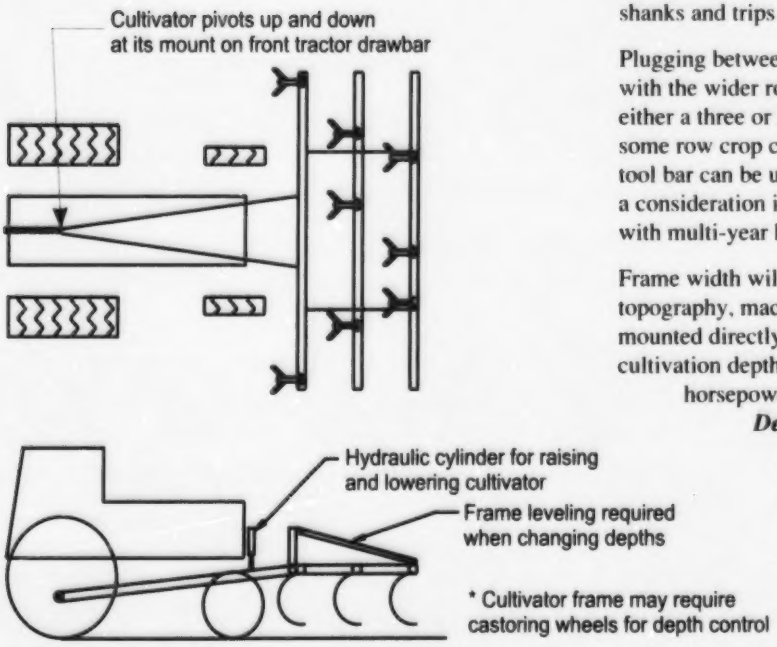
Cultivator pivots up and down
at its mount on front tractor drawbar
Hydraulic cylinder for raising
and lowering cultivator
Frame leveling required
when changing depths
* Cultivator frame may require
castoring wheels for depth control

Figure 1: Push cultivator mounted in front of tractor and connected to the rear hitch point.

Determine Row Spacing Requirements

Determine the row space requirements for the crops you are growing and will grow. Having moveable shanks allows for maximum flexibility. Ask yourself if the crop fills in towards the centre of the rows, and how much you will need to adjust the shank or tool width to accommodate this growth. Would a knock-on style opener by justified? The crop row spacing may need to be altered in the middle of the machine to accommodate your tractor tire spacing (Figure 3). This spacing may also be affected by your seeding equipment. Do you use a single row seeder or multiple row seeder with spacing that matches your cultivator? If the row crop cultivator will be used for seeding by adding a seed box on top, then tillage shanks with a seed opener should be installed where needed. This arrangement can also be used for marking rows when seeding one row at a time. The tillage shovels can be moved to the location of the seed rows and serve the dual purpose of marking the field (Figure 4).

Frame Size or Layout

Field cultivators were originally designed to be strong enough to work the soil at row spaces of 12 in. or less, with a full set of shovels. In row cropping you will be using at most only 2/3 of the shanks, so frame size or strength isn't a big concern. Make sure at least 2/3 of the shanks and trips are in good shape.

Plugging between the shanks shouldn't be a problem with the wider row spacing required for row crops, so either a three or four rank machine should be fine. In some row crop cases a double rank or even single rank tool bar can be used. Frame to ground clearance may be a consideration if you are tilling a tall crop, as is the case with multi-year herb crops (Figure 5).

Frame width will be a consideration depending on topography, machine levelling and whether it is drawn or mounted directly on the tractor. Frame width, tool type, cultivation depth and ground speed will all affect tractor horsepower requirements (See the section entitled ***Determining Horsepower Requirements***).

Some additional considerations for machine selection include:

- How easy is the machine to level front to back and side to side, and are all the adjustments still working?
- Are the remaining shanks still fairly tight especially sideways so they don't wander into the crop?

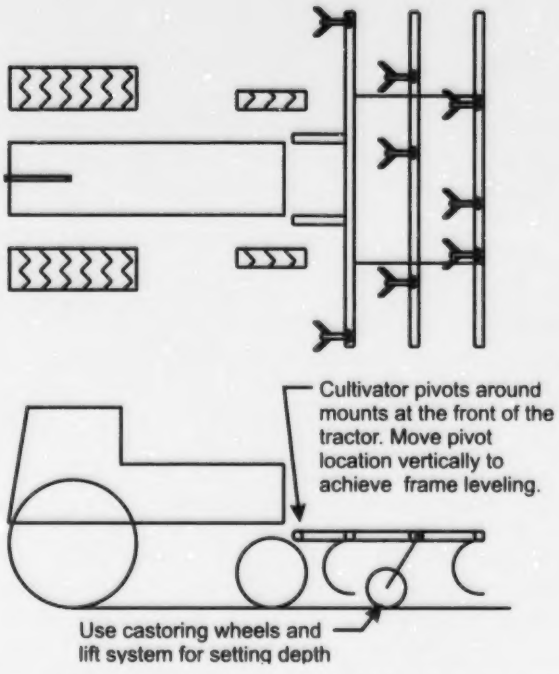
Cultivator pivots around mounts at the front of the tractor. Move pivot location vertically to achieve frame leveling.
Use castoring wheels and lift system for setting depth

Figure 2: Push cultivator mounted in front of tractor.

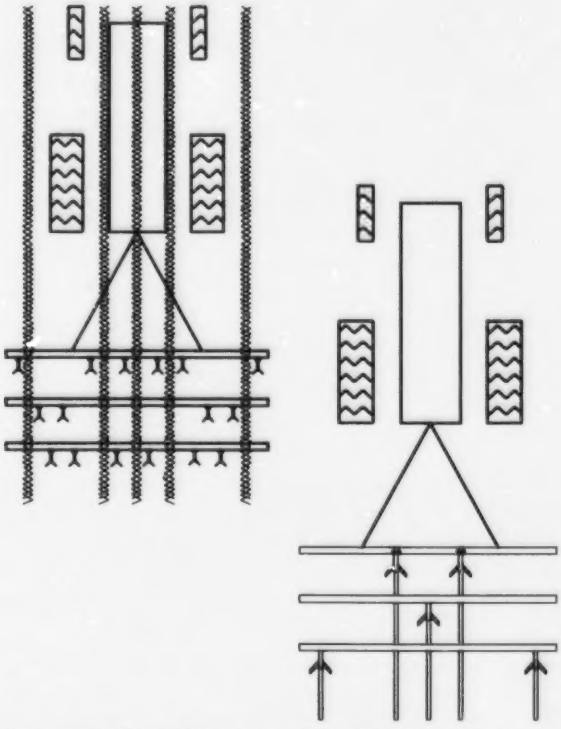

Figure 3 (left): Cultivating with an 18 in row spacing on a 12 foot machine. Figure 4 (right): Tillage shovels can be moved to the location of the seed rows and serve the dual purpose of marking the field.

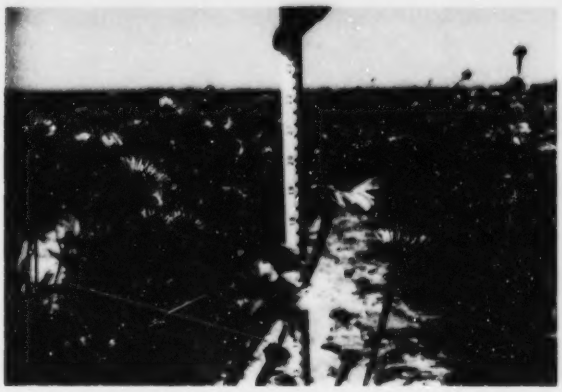

Figure 5. Crop height is an important consideration when converting a field cultivator to row crop use. PAMI photo.

• Ease of movement of the shanks, including sliding from side-to-side and removal and replacement on the frame, are major considerations especially if you are working in different crops and row spacing.

• How heavy are the shanks? Lighter shanks may wander more due to side stone impact or when a shank is working against a soil ridge.

Keeping Your Cultivator On Track

Tractor mounted cultivators, whether front or rear mounted, are guided by steering the tractor. Simple pointer type markers attached to the tractor can be used to assist the driver in this process.

But keeping your tractor-drawn cultivator on track in the field can be more difficult. When the cultivator is towed behind the tractor there is some lag time and difficulty ensuring tillage up to but not into the growing crop.

Guidance systems can help operators get close to the crop and reduce the need for hand weeding. Keep reading to find out more about different control systems to keep a towed cultivator in line.

Guide Wheels

Guide wheels are usually found on market garden, three-point hitch style equipment, and in principle should work well on towed machines also.

Guide wheels adjust cultivator tracking by riding in guide furrows or against ridges usually made at seeding. These systems allow the cultivator to move sideways, in relation to the tractor, within the limits of the hitch. By leaving the drawbar free to swing from side to side, the tractor simply pulls the cultivator and is only used to guide it in a general direction.

Encountering rocks, wind and rain erosion may affect guide wheel performance with a towed cultivator, though we did not observe any of these problems. A guide wheel system may be more suited to crops that are harvested yearly rather than crops that require a 2 or 3 year growing cycle, as ridges or furrows created during seeding will disappear over time and provide less direction to the cultivator. In addition, erosion, plant roots and other factors will become more prominent over time and may negatively affect cultivator tracking. The Williams Tool System uses guide wheels as a way of manually guiding the cultivator (Figure 6).

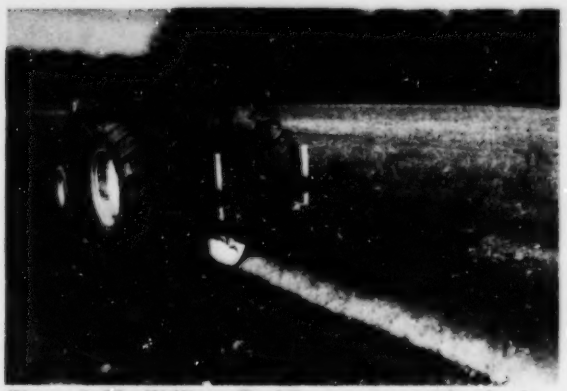

Figure 6. The Williams Tool System uses guide wheels as a way of manually guiding the cultivator. Market Farm Implement Catalogue photo, used by permission.

Hydraulic Guidance with Operator Assist

Charlie Coleman of McAuley, Manitoba, and row crop farmers in the United States have adapted and used variations of hydraulic guidance systems with tow behind cultivators. An operator sitting on the cultivator operates a hydraulic valve, which controls a cylinder connected to the swinging draw bar. By adjusting the valve, the operator can move the draw bar left or right, adjusting the cultivator to accommodate closer tillage to the crop (Figure 7).

Figure 7. Operator Steered Cultivators are safer if the operator is positioned at the rear of the cultivator, facing direction of travel. PAMI photo.

This modification is achieved by mounting a hydraulic cylinder underneath the tractor, approximately halfway between the draw pin and the front mounting pin on the drawbar. The cylinder rod end is positioned on the drawbar where the cylinder stroke in and out is matched to or greater than the sideways swing of the drawbar. The back of the cylinder is then mounted perpendicular to the draw bar when the drawbar is in its 'straight back' position.

A hydraulic 2-way valve is quick coupled into one of the remote circuits of the tractor. The hydraulic valve must be matched to either the open centre or closed centre system of the tractor. A standard 4 in. agricultural cylinder with an 8 in. stroke will work fine. A flow control valve on the hydraulics may be required to reduce the reaction speed of the cylinder to eliminate rapid drawbar whipping. The cultivator operator, by operating the valve, steers the cultivator to ensure proper tillage tracking. The hydraulics required for this system cost about $300 plus hoses. A basic layout of the hydraulic guidnce system appears in Figure 8.

When using this system it's easiest for the cultivator operator to line up the cultivator with a marker located above one row, rather than line up a shank with a buried shovel that is travelling close to the crop. The marker can be anything that hangs above one row of crop to aid in positioning. A disk used to hill the crop is easier to keep in line, as it is more visible than a shovel. The seat on the cultivator should be located at the rear of the machine for safety and ease of operation. The tractor operator then need only concentrate on tractor travel between rows.

Readers should be aware that these systems pose some risk to the operator from dust, falling off the machine, or potential injury due to shank breakage. Minimize hazards by carefully positioning the seat, using a seat belt, and wearing a suitable dust mask.

Automatic Guidance Systems

The automatic guidance system eliminates the need for a second operator on the cultivator. These systems use sensors to control the movement of the cultivator by either moving the hitch or by steering the tractor, and can also be used for guidance during seeding.

One type uses wire or plastic wands that run along the soil surface near the base of the plant. The wands rotate around a pivot point when contacting the crop, activating a micro switch and sending a signal to a hydraulic cylinder used to steer the unit (Figure 10). However, residue, protruding dirt or weed growth can compromise accurate row crop sensing.

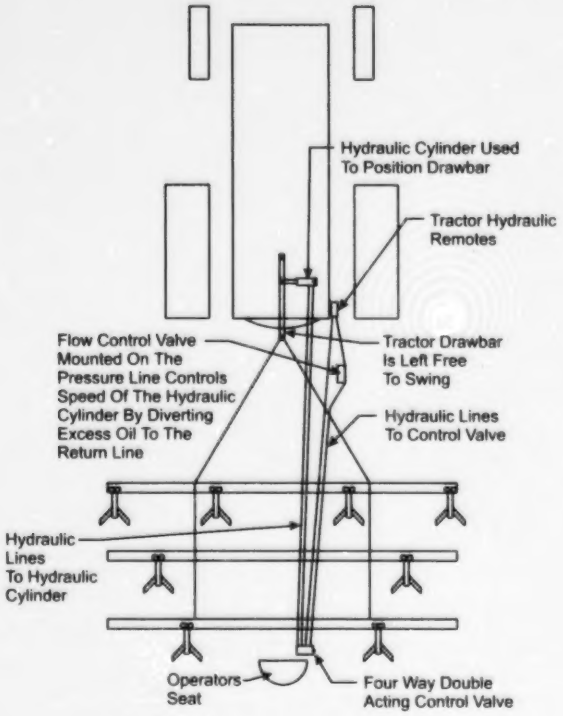

Figure 8: Concept for operator assist, hydraulically controlled guidance system.

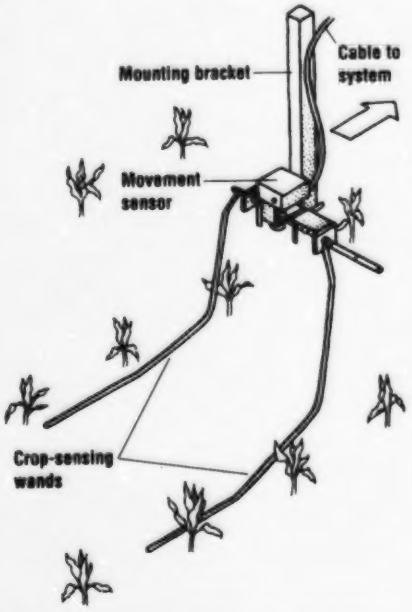

Figure 9. A guidance system using wire or plastic wands that run along the soil surface near the base of the plant. The wands rotate around a pivot point when contacting the crop, activating a micro switch and sending a signal to a hydraulic cylinder used to steer the unit. (Source: Steel in the Field,© 1997, The Sustainable Agriculture Network, used by permission)

Another system uses a sensor mounted at the front of the cultivator that straddles the crop, controlling the direction by sensing changes in the dirt height near the crop row. Sophisticated systems allow you to adjust the sensitivity so the system doesn't overreact to foreign obstacles. See Figures 11 - 15 for a pictorial overview of automated guidance systems.

None of the mentioned guidance systems, manual or automatic, have been evaluated by PAMI, and PAMI is not endorsing the use of any particular system.. Producers should investigate cost, performance and reliability before purchasing of these systems. See the section entitled ***Manufacturer's Addresses*** for contact information.

Wrap-up

While towed cultivators can be modified for three-point hitch or front attachment (and there may be advantages to doing this), we were not able to find any examples of such conversions. Expect a certain amount of trial and error work if you are attempting a three-point hitch or front-mount conversion.

Towed cultivators have been successfully adapted for row crop use in many instances. Your need for a guidance system will depend on your individual needs.

Figure 10. Tri-R Innovation System steers the tractor for seeding and cultivating (Planting operation shown here) Photo Source: Company Literature

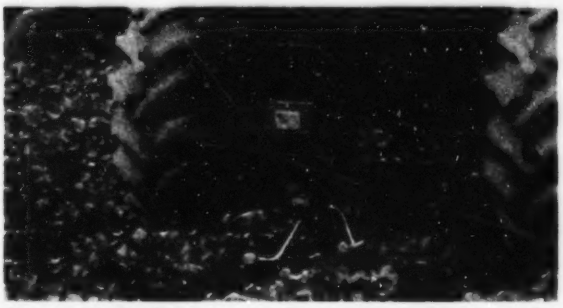

Figure 11. Tri-R Innovation System steers the tractor for seeding and cultivating (Cultivating operation shown here). Photo Source: Company Literature

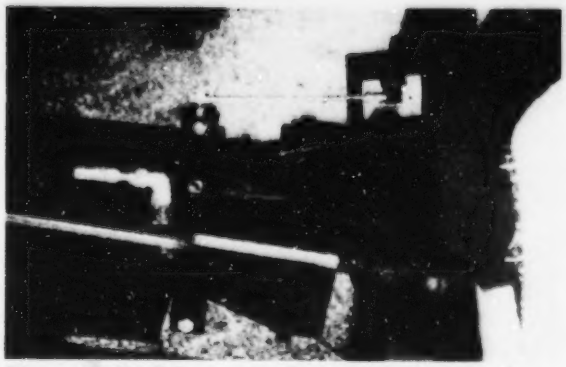

Figure 12. Tri-R Innovation System steering control – feedback sensor mounts onto steering axle. Photo Source: Company Literature

Figure 13. The Smart Hitch Guidance System steers the cultivator from the rear of the tractor. Photo Source:Smart Hitch photo, used by permission.

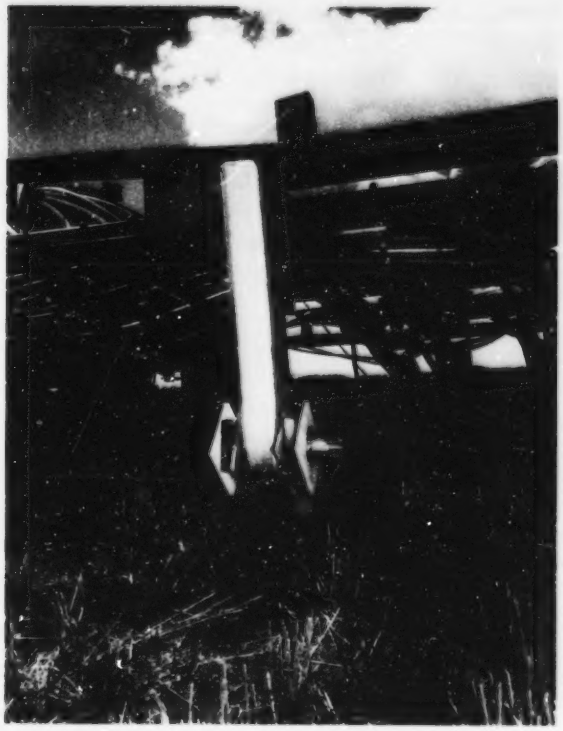

Figure 14. The Smart Hitch Guidance System mates to a steering mechanism on the cultivator. Photo Source: Western Producer/Michael Raine; Used by permission.

Herbs and Spices in Saskatchewan

Fast Facts:

- *The Saskatchewan Herb and Spice Association (SHSA) has about 300 members.*
- *Herb and spice production is just beginning to become mechanized, but is still a labour intensive operation. Machinery is being developed at the moment.*
- *There are about thirty different varieties of medicinal plants grown in Saskatchewan. These include three of the nine varieties of echinacea. Currently most commercial echinacea production is angustifolia.*
- *Some of the other herb varieties grown are St. John's wort, valerian, burdock, fireweed or willowherb, milk thistle, basil, chamomile and calendula.*
- *Extracts of fireweed are used in the cosmetic industry. Fytokem contracts both wildcrafted and commercial grown production.*

For more information, contact:

Saskatchewan Herb and Spice Association
Box 124
Sintaluta Sask.
S0G 4N0
Ph: 1-306-727-4917,
Fax: 1-306-727-2226

Determining Power Requirements

Draft Characteristics

Over the years, PAMI has measured the draft requirements of numerous full-scale cultivators in various field conditions. These measurements can be used to determine average draft requirements.

Draft requirements for the same cultivator in the same field may vary by as much as 30% in two different years due to changes in soil conditions. Variations in soil conditions affect draft much more than variations in machine brand, making it difficult to measure any significant draft differences between brands of cultivators.

PAMI's averaged results are a useful tool in determining tractor size requirements.

Recommended Tractor Size

Tables 1 and 2 show the tractor PTO power required to pull cultivators in various conditions at the given depths and speeds. Tractor power requirements have been adjusted to include a tractive efficiency of 80% in primary and 70% in secondary tillage and represent a tractor operating at 80% of maximum PTO power on a level field. These power requirements can be used along with the maximum PTO ratings, as determined by Nebraska tests or as presented by the tractor manufacturer, to select the appropriate tractor. Higher power will be required in hills or in heavy soils. Cultivators with marked differences in spacing, number of rows, or configuration may require more or less power.

Recommended tractor size may be determined by selecting the required horsepower per foot from the appropriate table and multiplying by the amount of tillage width (not crop width) of the cultivator. For example, in primary tillage at 2 in. (50 mm) and 4 mph (6.4 km/h), 2.7 hp/ft (6.6 kW/m) is required. Therefore, for a 12 ft (3.6 m) cultivator in those conditions, 33 PTO hp (25 kW) is recommended.

Table 1. Tractor PTO Power Per Unit Width (hp/ft (kW/m)) Required in Primary Tillage.

Depth		Speed – mph (km/h)					
In	(mm)	4.0	(6.4)	5.0	(8.0)	6.0	(9.7)
		Hp/ft	(kW/m)	Hp/ft	(kW/m)	Hp/ft	(kW/m)
2	(50)	2.7	(6.6)	3.4	(8.3)	4.1	(10.0)
3	(75)	3.8	(9.3)	4.8	(11.7)	5.8	(14.2)
4	(100)	4.9	(12.0)	6.1	(14.9)	7.4	(18.1)
5	(125)	6.0	(14.7)	7.5	(18.4)	9.0	(22.0)

Table 2. Tractor PTO Power Per Unit Width (hp/ft (kW/m)) Required in Secondary Tillage.

Depth		Speed – mph (km/h)					
In	(mm)	4.0	(6.4)	5.0	(8.0)	6.0	(9.7)
		Hp/ft	(kW/m)	Hp/ft	(kW/m)	Hp/ft	(kW/m)
2	(50)	2.3	(5.6)	3.0	(7.3)	3.6	(8.8)
3	(75)	3.4	(8.3)	4.3	(10.5)	5.2	(12.7)
4	(100)	4.5	(11.0)	5.6	(13.7)	6.8	(16.6)
5	(125)	5.5	(13.5)	7.0	(17.1)	8.4	(20.6)

PAMI wishes to thank the Agriculture Development Fund of Saskatchewan Agriculture and Food for its support in making this project possible.

Manufacturers Guide

Manual Guidance Systems

Alloway Ind.
1330 43rd ST NW
Fargo, ND 58102
Phone: (800) 289-3067
Fax: (701) 282-7043

Canadian Dealer –
Milliken Farm Supplies Ltd.
5614 64 St
Taber, AB T1G 1Y8
Phone: (403) 223-4437
Fax: (403) 223-3411

Kroeker Machinery Sales
PO Box 1026
Winkler, MB R6W 4B1
Phone: (204) 239-4947

Bezzerides Bros. Inc.
PO Box 211
Orosi, CA 93647
Phone: (559) 528-3011
Fax: (559) 528-9343

Canadian Dealer –
John C Graham Co Ltd.
88 Erie St N
Leamington, ON N8H 2Z6
Phone: (519) 326-5051

Bush Hog Corp.
2501 Griffin Ave
Selma, AL 36702-1039
Phone: (334) 872-6261
Fax: (334) 872-6262

Saskatchewan Dealers -
Ferre' Farm Equipment
601 Park Rd
Zenon Park, SK
Phone: (306) 767-2202

Harper Implements (1985) Ltd.
120 Simpson Ave
Birch Hills, SK
Phone: (306) 749-3588

Fennig Farm Equip Ltd.
4301-52nd St
Lloydminster, SK
(306) 825-4871

Nykolaishen Farm Equip Ltd.
Hwy 8 South
Kamsack, SK
Phone: (306) 542-2411

Oxbow Farm Centre Ltd.
Hwy 18 West
Oxbow, SK
Phone: (306) 483-2244

Farm World Equipment Ltd.
Kinistino, SK
Phone: (306) 864-2522

Farmfax Mgmt System, Inc.
Highway #6 North
Raymore, SK
Phone: (306) 746-2271

Sagal Bros Sales Ltd.
1030 N Service Rd
Moose Jaw, SK
Phone: (306) 692-7844

Agratec Int'l Ltd.
Hwy 318
Carnduff, SK
Phone: (306) 482-3377

Triod Supply (NB) Ltd.
2621 98th St
North Battleford, SK
Phone: (306) 445-1200

Moody's
Hwy 14
Perdue, SK
Phone: (306) 237-4272

Cropper Motors Inc.
Hwy #6 North
Naicam, SK
Phone: (306) 874-2011

Wagar Farm Equipment Ltd.
Hwy 9 & 49 West
Sturgis, SK
Phone: (306) 548-2966

Glenmor Grain Systems Ltd.
Old Hwy 2 South
Prince Albert, SK
Phone: (306) 764-2325

Ofe Farm Equip Ltd.
Hwy 15 West
Outlook, SK
Phone: (306) 867-8328

Hibbard Equip Ltd.
Main Street
Minton, SK
Phone: (306) 969-2133

Armstrong Imp (1993) Ltd.
625 N Railway St W
Swift Current, SK
Phone: (306) 773-7281

Dupont Holdings Ltd.
North Service Rd, Hwy 1
Swift Current, SK
Phone: (306) 773-8682

Wawota Garage Ltd.
Hwy 28 East
Wawota, SK
Phone: (306) 739-2377

FSH Inc.
PO Box 654
Henderson, NE 68371
Phone: (402) 723-4468

Market Farm Implement Catalogue
257 Fawn Hollow Road.
Friedens, PA 15541
Phone: (814) 443-1931
Fax: (814) 445-2238

Roll-A-Cone Mfg. & Dist.
Box 23 R2
Tulia, TX 79088
Phone: (806) 668-4722
Fax: (806) 668-4725

Sprayrite Mfg. Co.
PO Box 3289
West Helena, AR 72390
Phone: (870) 572-6737
Fax: (870) 572-6730

Automatic Guidance Systems

AGCO
4830 River Green Parkway
Duluth, GA 30136
Phone: (770) 813-9200
Fax: (770) 813-6038
www.AGCOCORP.com

Canadian Dealer -
Avenue Farm Machinery Ltd.
1521 Sumas Way
Box 369
Abbotsford, BC V2S 4N9
Phone: (604) 864-2665

Buffalo Farm Equipment
PO Box 848
Columbus, NE 68602-0848
Phone: (402) 564-3244
Fax: (402) 562-6112
www.buffalofarm.com

Canadian Dealer -
Apollo Distributing Corp
Highway 1 E
Emerald Park, SK
Phone: (306) 781-2644
Fax: (306) 781-2599

Automatic Equipment Manufacturing
One Mill Road, Industrial Park
Pender, NE 68074
Phone: 402) 385-3220
www.automaticag.com

Lincoln Creek Mfg.
RD 1 Box 41
Phillips, NE 68865
Phone: (402) 886-2483
Fax: (402) 886-2274

Sukup Mfg. Co.
Box 677
Sheffield, IA 50475-0677
Phone: (515) 892-4222
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Canadian Independent
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Jim Armstrong
Phone: (519) 657-1787

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Phone: (306) 735-2208
Fax: (306) 735)2349
Email:
strawtrack@sk.sympatico.ca

Tri-R Innovations, Inc.
628 S. Sangamon Ave.
Gibson City, IL 60936
Phone: (217) 784-8495

SUNCO Marketing (Acura-Trak)
4320 Rodeo Rd
North Platte, NE 69101-1007
Phone: (308) 532-2146
Email: sunco@nponline.net

Canadian Dealer -
Grower Supply Ltd.
401 1st St N
Vauxhall, AB T0K 2K0
Phone: (403) 654-2223
Fax: (403) 654-2414

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Humboldt, Saskatchewan, Canada S0K 2A0
Telephone: (306) 682-5033
FAX: (306) 682-5080
email: humboldt@pami.ca

P.O. Box 1060
Portage la Prairie, Manitoba, Canada R1N 3C5
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